Component of Statistics Canada Catalogue no. 82-003-X
Health Reports

Article

Prevalence of Chlamydia trachomatis and herpes simplex virus type 2: Results from the 2009 to 2011 Canadian Health Measures Survey

by Michelle Rotermann, Kellie A. Langlois, Alberto Severini and Stephanie Totten

April, 2013

Statistics Canada Statistique Canada

Canada

How to obtain more information

For information about this product or the wide range of services and data available from Statistics Canada, visit our website, www.statcan.gc.ca.

You can also contact us by

email at infostats@statcan.gc.ca,

telephone, from Monday to Friday, 8:30 a.m. to 4:30 p.m., at the following toll-free numbers:

- Statistical Information Service 1-800-263-1136
- National telecommunications device for the hearing impaired 1-800-363-7629
- Fax line 1-877-287-4369

Depository Services Program

- Inquiries line 1-800-635-7943
- Fax line 1-800-565-7757

To access this product

This product, Catalogue no. 82-003-X, is available free in electronic format. To obtain a single issue, visit our website, www.statcan.gc.ca, and browse by "Key resource" > "Publications."

Standards of service to the public

Statistics Canada is committed to serving its clients in a prompt, reliable and courteous manner. To this end, Statistics Canada has developed standards of service that its employees observe. To obtain a copy of these service standards, please contact Statistics Canada toll-free at 1-800-263-1136. The service standards are also published on www.statcan.gc.ca under "About us" > "The agency" > "Providing services to Canadians."

Published by authority of the Minister responsible for Statistics Canada

© Minister of Industry, 2013.

All rights reserved. Use of this publication is governed by the Statistics Canada Open Licence Agreement (http://www.statcan.gc.ca/reference/licence-eng.html).

Cette publication est aussi disponible en français.

Note of appreciation

Canada owes the success of its statistical system to a long-standing partnership between Statistics Canada, the citizens of Canada, its businesses, governments and other institutions. Accurate and timely statistical information could not be produced without their continued co-operation and goodwill.

Standard symbols

The following symbols are used in Statistics Canada publications:

.	not available for any reference period
..	not available for a specific reference period
...	not applicable
0	true zero or a value rounded to zero
0s	value rounded to 0 (zero) where there is a meaningful distinction between true zero and the value that was rounded
p	preliminary
r	revised
x	suppressed to meet the confidentiality requirements of the *Statistics Act*
E	use with caution
F	too unreliable to be published
*	significantly different from reference category ($p < 0.05$)

Prevalence of *Chlamydia trachomatis* and herpes simplex virus type 2: Results from the 2009 to 2011 Canadian Health Measures Survey

by Michelle Rotermann, Kellie A. Langlois, Alberto Severini and Stephanie Totten

Abstract

Background

Chlamydia, caused by *Chlamydia trachomatis*, and genital herpes, caused by simplex virus type 2 (HSV-2), are common sexually transmitted infections. Their prevalence has been estimated in selected populations, but overall prevalence in Canada is not known.

Data and methods

Data are from the 2009 to 2011 Canadian Health Measures Survey. Socio-demographic, health and lifestyle information was obtained via a household questionnaire; blood and urine collected at a mobile examination centre were used to identify the presence of *Chlamydia trachomatis* and HSV-2 among 14- to 59-year-olds.

Results

An estimated 13.6% of Canadians (2.9 million) tested positive for HSV-2, and another 0.7% (158,000), for chlamydia. HSV-2 affects higher percentages of women than men, and individuals aged 35 to 59 versus 15 to 34. No significant differences in HSV-2 prevalence were detected by marital status, household income, education, or racial background. Nearly all individuals with laboratory-confirmed chlamydia or HSV-2 were unaware that they were infected.

Interpretation

This study is the first in Canada to report laboratory-confirmed prevalence of chlamydia and HSV-2 using a nationally representative sample. Results suggest that most infected people are unaware of their status.

Keywords

Disease notification, health surveys, sexually transmitted diseases.

Authors

Michelle Rotermann (michelle.rotermann@statcan.gc.ca; 1-613-951-3166) and Kellie A. Langlois (kellie.langlois@statcan.gc.ca; 1-613-951-3806) are with the Health Analysis Division at Statistics Canada, Ottawa, Ontario, K1A 0T6. Alberto Severini and Stephanie Totten are with the Public Health Agency of Canada.

Information about the prevalence of sexually transmitted infections (STIs) in Canada tends to be limited—not all STIs are notifiable[1]; under-reporting may occur [2,3]; and because of selection bias, generalizability is restricted.[4] And even for nationally notifiable infections, data derived from routine surveillance capture only cases that are diagnosed and reported to public health authorities.

Chlamydia is the most commonly reported notifiable infection in Canada.[5] Data are available from surveillance of cases identified through voluntary testing,[5] and from targeted studies of specific populations and geographies.[6,7] But because many chlamydia infections are asymptomatic, some cases go undiagnosed and untreated.[1]

For herpes simplex virus type 2 (HSV-2), the most frequent cause of genital herpes,[8,9] official national statistics are not maintained.[1] Prevalence information has largely been based on targeted studies of specific populations,[10-14] and administrative health service or laboratory data.[15-19] HSV-2 infections are frequently asymptomatic, or may have atypical presentations, and as a result, affected individuals may not seek testing and treatment.[1]

Chlamydia and HSV-2 are spread primarily by intimate physical contact, usually sexual intercourse, with an infected partner. Infection with one STI can increase the risk of contracting others, including the human immunodeficiency virus (HIV).[18-20] Re-infection with chlamydia is common after repeated exposure (for example, unprotected sexual activity with an infected partner).[1] Untreated infections can cause gynecological and reproductive complications[21-23] and may adversely affect the health of infants exposed during childbirth.[24-28]

Given the often asymptomatic nature of chlamydia and HSV-2, their prevalence in the general population is difficult to estimate. This study is the first in Canada to report laboratory-confirmed prevalence estimates for chlamydia and HSV-2 using a nationally representative

sample. The analysis is based on physical measures data collected as part of the 2009 to 2011 Canadian Health Measures Survey (CHMS), an ongoing survey conducted by Statistics Canada in partnership with the Public Health Agency of Canada and Health Canada.

Methods

Data source

The data are from cycle 2 of the CHMS, which took place from August 2009 through November 2011. Information was collected at 18 locations across the country from respondents aged 3 to 79 living in private households. Residents of Indian Reserves, institutions and some remote regions, and full-time members of the Canadian Forces were excluded. The sample represents more than 96% of the population.[29] Ethics approval for the survey was obtained from Health Canada's Research Ethics Board.[30] Detailed information about the content and sample design of the CHMS is available elsewhere.[29-31]

In addition to an in-person interview to gather socio-demographic, health and lifestyle information, the survey involved a subsequent visit to a mobile examination center for direct physical measures, including blood and urine collection. Respondents unable to visit the centre could opt to have their direct measures taken at home.[31]

Of the households selected, 75.9% agreed to participate, and 88.5% of selected household members aged 14 to 59 completed the household questionnaire. A total of 3,329 respondents (82.1% of those who responded to the household questionnaire) completed the mobile examination centre component. The final response rate for 14- to 59-year-olds, after adjusting for the sampling strategy, was 54.6%.

Many infectious diseases, if identified during clinical practice, must be reported to health authorities. Positive results from CHMS testing for chlamydia are reportable, yet are protected by the confidentiality provisions of the Statistics Act. The CHMS respected these competing requirements by asking respondents, before they were tested, for permission to share positive test results with health authorities.

Respondents were excluded from this study if:

- They were aged 3 to 13 (n=1,978) or aged 60 or older (n=1,098), and therefore, ineligible for testing.
- Blood was not collected for medical reasons, such as hemophilia or receipt of chemotherapy in the past 4 weeks (n<10).
- Conditions and circumstances, such as being in a wheelchair or having a catheter, prevented urine collection (n<10).
- The test(s) was (were) not performed because the respondent did not consent to disclosure (n=27); results were indeterminate (n<10); or samples were unavailable or insufficient (HSV-2: n=42; chlamydia: n=44).

The HSV-2 and chlamydia estimates in this article are based, respectively, on 3,247 and 3,250 respondents aged 14 to 59.

Urine and blood collection

First-catch urine for chlamydia testing was collected in 120 ml containers during the mobile examination centre visit. About half of the urine specimens were collected in accordance with the chlamydia testing protocol—that is, at least two hours after respondents' most recent urination; the other half were collected from respondents who had urinated more recently. No statistically significant differences in chlamydia prevalence were found between samples collected in compliance with the two-hour voiding interval and those that were not (data not shown).

At the mobile examination centre, blood was collected by venipuncture into vacutainers. The pooled serum was processed for HSV-2 in addition to other virus biomarkers.

Standardized procedures for the collection, handling, processing, aliquoting and shipping of the bio-specimens, and participation in proficiency testing programs ensured the quality and comparability of the test results.[32] Samples were shipped weekly and processed by the National Microbiology Laboratory in Winnipeg, Manitoba according to the manufacturers' instructions.

Infection markers

Chlamydia

Urine samples from respondents aged 14 to 59 were frozen within four hours of collection and tested for *Chlamydia trachomatis* with the Roche Amplicor® detection kit, a PCR-based method that targets the chlamydia cryptic plasmid.[33] According to the manufacturer, sensitivity and specificity for this test are 96.8% and 94.3%, respectively, compared with culture isolation. A positive result indicates prevalent infection with *Chlamydia trachomatis*.

Herpes simplex virus type 2

Serum from the blood collected from respondents aged 14 to 59 was analysed using the HerpeSelect® ELISA IgG assay (Focus Diagnostics) to screen for HSV-2 antibodies,[32] with 1.10 as the cut-off "index" value for positivity, as recommended by the manufacturer. This assay uses the HSV-2 glycoprotein G as the type-specific antigen and can discriminate between herpes simplex virus types 1 and 2 antibodies.[34] Specimens with index values in the inconclusive range (0.90 to 1.10) were retested. Values exceeding 1.10 indicate life-long infection, latent or symptomatic, with HSV-2. Fewer than 10 cases had inconclusive test results and were excluded from the analysis. According to the manufacturer,[32] the test's sensitivity and specificity among sexually active adults are 96.1% and 97.0%, respectively, and are in agreement with published studies using Western blot, which is the gold standard.[35]

Covariates

Age group, sex, household income, education, marital status, racial background, and previous diagnosis of a sexually transmitted infection were examined in association with HSV-2. Three age groups were specified: 14 to 34, 35 to 49, and 50 to 59.

Household income, adjusted for household size, was classified into two categories: higher and lower. Households were considered to be lower income if their total earnings in the past year were less than $30,000 (one or two members), less than $40,000 (three or four members), or less than $60,000 (five or more members). Income was imputed for fewer than 20% of the overall sample; details are available elsewhere.[29]

Education was dichotomized as less than postsecondary graduation and postsecondary graduation. For 14- to 24-year-olds, the highest level of education in the household was used.

Marital status was assessed using the following categories: never married, married, living with a partner, separated, divorced, and widowed. For this analysis, those who were never married, separated, divorced or widowed were grouped as "unmarried" to represent the population more likely to initiate new sexual relationships. Those who were married or living with a partner were classified as "married/cohabiting" to represent those less likely to initiate new sexual relationships.

Respondents could choose from an extensive list of racial backgrounds, with individuals indicating "White" being classified as such, and all others combined into "non-White."

Respondents were asked if they had ever been diagnosed with a sexually transmitted infection, and if so, which one(s). They could report more than one diagnosis. The list included genital herpes (HSV-2) and chlamydia.

Analytical techniques

The prevalence of chlamydia (from urine) and HSV-2 (from blood serum) was estimated using weighted data. To account for survey design effects, coefficients of variation and 95% confidence intervals were estimated with the bootstrap technique.[37,38] Differences between prevalence estimates were calculated using t-tests. All analyses were conducted in SUDAAN v.10 (RTI International, Research Triangle Institute, NC, USA), using DDF=13 in the procedure statements to account for the degrees of freedom.

Results

Chlamydia

According to the 2009 to 2011 CHMS, the overall prevalence of *Chlamydia trachomatis* infection in the urine of 14- to 59-year-olds was 0.7% (95% confidence interval 0.4% to 1.3%) (a weighted estimate of 158,000 individuals) (data not shown). Because of sample size constraints, further analyses were not conducted.

Herpes simplex virus type 2

The seroprevalence of HSV-2 type-specific antibodies among people aged 14 to 59 was 13.6% (an estimated 2.9 million) (Table 1). The overall seroprevalence of HSV-2 was higher among females than males (16.1% versus 11.0%); this difference was most apparent among younger people, postsecondary graduates, and individuals who reported their racial background to be White. The prevalence of infection rose from around 6% at ages 14 to 34 to about 19% among people aged 35 or older. No differences were found by marital status, household income, education, or racial background.

Most unaware of infection

During the household interview, CHMS respondents were asked if they had ever been diagnosed with an STI, and if so, which one(s). Blood and urine collected at the mobile examination centre were tested to cross-validate these results.

No respondents who tested positive for chlamydia reported ever having been diagnosed with an STI (data not shown). Among those who tested positive for HSV-2, 6% reported having been diagnosed with the infection; 94% were unaware that they were infected (Table 2). In general, awareness of infection did not differ significantly by age group or sex, although it tended to increase with age.

Table 1
Prevalence of herpes simplex virus type 2, by selected characteristics, household population aged 14 to 59, Canada, 2009 to 2011

	Total			Male			Female		
		95% confidence interval			95% confidence interval			95% confidence interval	
Characteristic	%	to	from	%	to	from	%	to	from
Total 14 to 59	13.6	11.2	16.4	11.0	8.2	14.7	16.1‡	13.4	19.3
Age group									
14 to 34†	6.1‡	3.9	9.5	3.5‡	1.9	6.2	8.9‡	5.3	14.4
35 to 49	19.1*‡	13.1	26.9	16.0*‡	9.6	25.6	22.3*‡	14.7	32.3
50 to 59	18.9*	13.8	25.2	17.8*‡	11.1	27.4	19.9*	14.0	27.4
Marital status									
Married/Cohabiting†	14.9	11.7	18.8	12.4	8.6	17.5	17.0	12.8	22.2
Not married	11.8	8.8	15.6	9.6‡	6.2	14.5	14.6	10.3	20.3
Household income									
Higher†	13.7	10.7	17.3	11.9	8.3	16.7	15.6	11.7	20.5
Lower	17.3‡	9.7	29.0	< 31.6	.	.	20.7‡	11.6	34.2
Imputed	11.3‡	7.4	17.0	7.7‡	3.9	14.6	14.7‡	8.7	23.8
Education									
Less than postsecondary graduation	14.2	10.3	19.3	11.9‡	6.8	20.0	16.6	12.1	22.3
Postsecondary graduation†	13.7	11.1	16.8	11.2	8.0	15.5	16.2‡	13.3	19.6
Race									
White†	12.7	10.3	15.6	9.9	7.1	13.7	15.5‡	12.3	19.5
Non-White	16.2‡	10.4	24.3	14.5‡	7.7	25.5	17.9‡	11.3	27.1

† reference category
* significantly different from reference category ($p < 0.05$)
‡ significantly different from male ($p < 0.05$)
E use with caution
. . not applicable
Note: If coefficient of variation of estimate exceeds 33.3%, estimate is indicated as being less than upper limit of 95% confidence interval.
Source: 2009 to 2011 Canadian Health Measures Survey.

Discussion

The present study is the first to analyze the prevalence of chlamydia and HSV-2 based on direct measures of a nationally representative sample of age-eligible Canadians. The 2009 to 2011 CHMS results are comparable to those of the National Health and Nutrition Examination Survey (NHANES) in the United States, the Australian Diabetes, Obesity and Lifestyle Study (AusDiab) in Australia, and the National Survey of Sexual Attitudes and Lifestyles (Natsal) in Britain. For instance, based on the 2005 to 2008 NHANES, the seroprevalence estimate for HSV-2 among 14- to 49-year-olds was 16.2%,[38] and the 2007 to 2008 chlamydia prevalence among 14- to 39-year-olds was 1.6%.[39] AusDiab (1999 to 2000) reported an HSV-2 prevalence of 12% among Australians aged 25 or older.[40] Natsal's chlamydia prevalence was estimated at 2.2% for men and 1.5% for women.[41]

Similar to CHMS results, HSV-2 seroprevalences in NHANES and AusDiab tended to be higher among older than younger age groups, and higher among females than males.[38-40,42-44] However, contrary to the NHANES or AusDiab analyses, and likely because of limited statistical power, CHMS HSV-2 seroprevalence estimates did not differ by marital status[42-44] or socio-economic status.[42]

Few, if any, CHMS respondents who were positive for chlamydia or HSV-2 were aware of it. This is consistent with other research. For example, 85.7% of Americans who were sero-positive for HSV-2 did not know they were infected,[44] and high percentages with chlamydia were undiagnosed.[41] Lack of symptoms may be a reason why many people who are positive for HSV-2 or chlamydia do not know that they are infected.[45,46]

Limitations

Logistical and budget constraints affected the number of CHMS collection sites and the overall sample size.[29] As a result, it was sometimes necessary to use more general variable definitions than would have been preferable for this analysis. Sample size limited elaboration of influential factors such as geography, Aboriginal identity, and sexual orientation, and may have reduced the ability to identify statistical significance.

The CHMS excludes some populations at potentially high-risk for STIs, such as people who are homeless.[1]

Herpes simplex virus type 1 (HSV1) is becoming an important cause of genital herpes, accounting for an estimated 40% of genital infections in Canada,[17] and at least half of such infections in other developed countries.[40,47,48] Because the CHMS screened only for HSV-2, infections caused by HSV1 will be missed, which may be particularly important at younger ages.[16,17]

The overall response rate to the CHMS for 14- to 59-year-olds was 54.6%. Survey weights ensured that the sample is representative of the target population, but bias may exist if the infection status of non-respondents differed systematically from that of participants.

The CHMS used a combination of self-reported, clinic, and laboratory data. While self-reported data are subject to social desirability and recall biases, laboratory data are also imperfect. Deviation from specimen collection and storage protocols can compromise test results,[29] and nearly all directly measured tests fail to correctly identify some percentage of true positives and negatives.[32]

What is already known on this subject?

- Chlamydia and herpes simplex virus type 2 (HSV-2) can have serious immediate and long-term physical and psychological consequences.
- In Canada, information about chlamydia and HSV-2 prevalence has been derived from data collected from voluntary testing, screening of high-risk populations, and/or administrative health services or laboratory data.

What does this study add?

- Based on the results of urine and blood analyses conducted by the 2009 to 2011 Canadian Health Measures Survey, this study reports nationally representative prevalence estimates of chlamydia and HSV-2.
- An estimated 13.6% of Canadians aged 14 to 59 (2.9 million) tested positive for HSV-2, and 0.7% (158,000), for chlamydia.
- Nearly all individuals with laboratory-confirmed HSV-2 and all individuals with laboratory-confirmed chlamydia did not know that they were infected.

Table 2
Percentage unaware of infection status among those with lab-confirmed herpes simplex virus type 2, by age group and sex, household population aged 14 to 59, Canada, 2009 to 2011

	Total			Male			Female		
		95% confidence interval			95% confidence interval			95% confidence interval	
Age group	%	from	to	%	from	to	%	from	to
Total 14 to 59	94.0	88.1	97.1	94.6	81.9	98.5	93.6	85.3	97.3
14 to 34†	99.0	95.9	99.8	100.0	..	..	98.7	94.5	99.7
35 to 49	93.2*	83.6	97.3	91.6	68.5	98.2	94.3	85.4	97.9
50 to 59	92.6	80.2	97.5	97.3	91.3	99.2	88.7	62.3	97.4

† reference category
* significantly different from reference category ($p < 0.05$)
.. not applicable
Source: 2009 to 2011 Canadian Health Measures Survey

Conclusion

The results of this analysis show that at ages 14 to 59, the prevalence of chlamydia is less than 1%, and that HSV-2 affects about 14% of the people in this age range. A comparison of laboratory-confirmed infections with self-reports of diagnoses suggests that almost all respondents testing positive for chlamydia or HSV-2 were unaware that they were infected. The estimates in this study serve as baseline data to track trends in prevalence. As additional waves of CHMS data become available, it may be possible to combine cycles to more fully investigate risk factors of laboratory-confirmed STIs, and potentially, to explore the health outcomes and health service use of those infected. ■

References

1. Expert Working Group for the Canadian Guidelines on Sexually Transmitted Infections. Chlamydial infections. In: Wong T, Latham-Carmanico C, eds. *Canadian Guidelines on Sexually Transmitted Infections*. Ottawa: Public Health Agency of Canada, 2010. Available at: http://www.phac-aspc.gc.ca/std-mts/sti-its/.
2. Hill A. Indifferent reporting of notifiable diseases. *Canadian Medical Association Journal* 2012; 184(10): E513-4.
3. Friedman SM, Sommersall L-A, Gardam M, et al. Suboptimal reporting of notifiable diseases in Canadian emergency departments: A survey of emergency physician knowledge, practices, and perceived barriers. *Canadian Communicable Disease Report* 2006; 32(17). Available at: http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/06vol32/dr3217a-eng.php.
4. McKay A, Barrett M. Rising reported rates of chlamydia among young women in Canada: What do they tell us about trends in the actual prevalence of the infection? *Canadian Journal of Human Sexuality* 2008; 17(1-2): 61-9.
5. Public Agency of Canada. *Report on Sexually Transmitted Infections in Canada: 2008*. Ottawa: Public Health Agency of Canada, 2010. Available at: http://www.phac-aspc.gc.ca/std-mts/report/sti-its2008/06-eng.php#a0602.
6. Lemstra M, Neudorf C, Opondo J, et al. Epidemiological analysis of Chlamydia Trachomatis and Neisseria Gonorrhoeae in Saskatoon Health Region. *Canadian Journal of Public Health* 2007; 98(2): 134-7.
7. Shields SA, Wong T, Mann J, et al. Prevalence and correlates of chlamydia infection in Canadian street youth. *Journal of Adolescent Health* 2004; 34: 384-90.
8. Gottlieb S, Ndowa F. Herpes simplex. In: Heymann D, ed., *Control of Communicable Diseases Manual. 19th Edition*. Washington, DC: American Public Health Association, 2008: 300-4.
9. Looker KJ, Garnett GP, Schmid GP. An estimate of the global prevalence and incidence of herpes simplex virus type 2 infection. *Bulletin of the World Health Organization* 2008; 86(10): 805-12.
10. Singh AE, Romanowski B, Wong T, et al. Herpes simplex virus seroprevalence and risk factors in 2 Canadian sexually transmitted disease clinics. *Sexually Transmitted Diseases* 2005; 32(2): 95-100.
11. Howard M, Sellors JW, Jang D, et al. Regional distribution of antibodies to herpes simplex virus type 1 (HSV-1) and HSV-2 in men and women in Ontario, Canada. *Journal of Clinical Microbiology* 2003; 41(1): 84-9.
12. Patrick DM, Dawar M, Cook DA, et al. Antenatal seroprevalence of herpes simplex virus type 2 (HSV-2) in Canadian women: HSV-2 prevalence increases throughout the reproductive years. *Sexually Transmitted Diseases* 2001; 28(7): 424-8.
13. Steenbeek A, Tyndall M, Sheps S, et al. An epidemiological survey of chlamydial and gonococcal infections in a Canadian Arctic community. *Sexually Transmitted Diseases* 2009; 36(2): 79-83.
14. Public Health Agency of Canada. *Sexually Transmitted Infections in Canadian Street Youth – Findings from Enhanced Surveillance of Canadian Street Youth, 1999-2003*. Ottawa: Public Health Agency of Canada, 2006. Available at: http://www.phac.aspc.gc.ca/std-mts/reports_06/pdf/sti-street_youth_e.pdf.
15. Aslam M, Kropp RY, Jayaraman G, et al. Genital herpes in Canada: Deciphering the hidden epidemic. *Canadian Journal of Infectious Disease in Medicine and Microbiology* 2012; 23(1): e6-9.
16. Forward KR, Lee SHS. Predominance of herpes simplex virus type 1 from patients with genital herpes in Nova Scotia. *Canadian Journal of Infectious Diseases* 2003; 14(2): 94-6.
17. Gilbert M, Li X, Petric M, et al. Using centralized laboratory data to monitor trends in Herpes Simplex Virus Type 1 and 2 Infection in British Columbia and the changing etiology of genital herpes. *Canadian Journal of Public Health* 2011; 102(3): 225-9.
18. Fleming DT, Wasserheit JN. From epidemiological synergy to public health policy and practice: the contribution of other sexually transmitted diseases to sexual transmission of HIV infection. *Sexually Transmitted Infections* 1999; 75(1): 3-17.
19. Wald A, Link K. Risk of human immunodeficiency virus infection in herpes simplex virus type 2-seropositive persons: A meta-analysis. *The Journal of Infectious Diseases* 2002; 185: 45-52.
20. Freeman EE, Weiss HA, Glynn JR, et al. Herpes simplex virus 2 infection increases HIV acquisition in men and women: Systematic review and meta-analysis of longitudinal studies. *AIDS* 2006; 20: 73-83.
21. Paavonen J, Westrom L, Eschenbach D. Pelvic inflammatory disease. In: Holmes KK, Sparling PF, Stamm W, et al., eds. *Sexually Transmitted Diseases. Fourth Edition*. New York: McGraw-Hill Medical, 2008: 1017-50.
22. Land JA, Van Bergen JEAM, Morré SA, et al. Epidemiology of Chlamydia trachomatis infection in women and the cost-effectiveness of screening. *Human Reproduction Update* 2010; 16(2): 189-204.
23. Rours GIJG, Duijts L, Moll HA, et al. Chlamydia trachomatis infection during pregnancy associated with preterm delivery: a population-based prospective cohort study. *European Journal of Epidemiology* 2011; 26: 493-502.
24. Johnson R, Ndowa F. Chlamydial infections. In: Heymann D, ed. *Control of Communicable Diseases Manual. 19th Edition*. Washington, DC: American Public Health Association, 2008: 116-9.

25. Rours GIJG, Hammerschlag MR, Ott A, et al. Chlamydia trachomatis as a cause of neonatal conjunctivitis in Dutch infants. *Pediatrics* 2008; 121(2): e321-6.

26. Rours GIJG, Hammerschlag MR, Van Doornum GJJ, et al. Chlamydia trachomatis respiratory infection in Dutch infants. *Archives of Disease in Childhood* 2009; 94(9): 705-7.

27. Kimberlin DW. Herpes simplex virus infections of the newborn. *Seminars in Perinatology* 2007; 31: 19-25.

28. Kropp RY, Wong T, Cormier L, et al. Neonatal herpes simplex virus infections in Canada: results of a 3-year national prospective study. *Pediatrics* 2006 ; 117(6): 1955-62.

29. Statistics Canada. *Canadian Health Measures Survey (CHMS) Data User Guide: Cycle 2* April 2013. Available at: http://www23.statcan.gc.ca/imdb-bmdi/document/5071_D4_T9_V1-eng.htm.

30. Day B, Langlois R, Tremblay M, Knoppers B-M. Canadian Health Measures Survey: ethical, legal and social issues. *Health Reports* 2007; 18(Suppl.): 37-51.

31. Tremblay M, Wolfson M, Connor Gorber S. Canadian Health Measures Survey: Rationale, background and overview. *Health Reports* 2007; 18(Suppl.): 7-20.

32. Statistics Canada. *Canadian Health Measures Survey (CHMS) Standard Operating Procedures for Laboratory Infection Markers: Cycle 2*. 2012. Unpublished.

33. Loeffelholz MJ, Lewinski CA, Silver SR, et al. Detection of Chlamydia trachomatis in endocervical specimens by polymerase chain reaction. *Journal of Clinical Microbiology* 1992; (11): 2847-51.

34. Wald A, Ashley-Morrow R. Serological testing for herpes simplex virus (HSV)-1 and HSV-2 infection. *Clinical Infectious Diseases* 2002; 35(Suppl. 2): S173-8.

35. Ratnam S, Severini A, Zahariadis G, et al. The diagnosis of genital herpes - beyond culture: An evidence-based guide for the utilization of polymerase chain reaction and herpes simplex virus type-specific serology. *Canadian Journal of Infectious Diseases and Medical Microbiology* 2007; 18(4): 233-40.

36. Rao JNK, Wu CFJ, Yue K. Some recent work on resampling methods for complex surveys. *Survey Methodology* 1992; 18(2): 209-17.

37. Rust KF, Rao JNK. Variance estimation for complex surveys using replication techniques. *Statistical Methods in Medical Research* 1996; 5(3): 281-310.

38. Centers for Disease Control. Seroprevalence of herpes simplex virus type 2 among persons aged 14-49 years—United States, 2005-2008. *Morbidity and Mortality Weekly Report* 2010; 59(15): 456-9.

39. Datta SD, Torrone E, Kruszon-Moran D, et al. Chlamydia trachomatis trends in the United States among persons 14 to 39 years of age, 1999-2008. *Sexually Transmitted Diseases 2012*; 39(2): 92-6.

40. Cunningham AL, Taylor R, Taylor J, et al. Prevalence of infection with herpes simplex virus types 1 and 2 in Australia: a nationwide population based survey. *Sexually Transmitted Infection* 2006; 82(2): 164-8.

41. Fenton KA, Korovessis C, Johnson AM, et al. Sexual behavior in Britain: reported sexually transmitted infections and prevalent genital Chlamydia trachomatis infection. *The Lancet* 2001; 358: 1851-4.

42. Fleming DT, McQuillan GM, Johnson RE, et al. Herpes simplex virus type 2 in the United States, 1976 to 1994. *New England Journal of Medicine* 1997; 337(16): 1105-11.

43. Bauer GR, Khobzi N, Coleman TA. Herpes simplex virus type 2 seropositivity and relationship status among U.S. adults age 20 to 49: A population-based analysis. *BMC Infectious Diseases* 2010; 10: 359.

44. Xu F, Sternberg MR, Kottiri BJ, et al. Trends in herpes simplex virus type 1 and type 2 seroprevalence in the United States. *Journal of the American Medical Association* 2006; 296(8): 964-73.

45. Centers for Disease Control. *Sexually Transmitted Infection Guidelines 2010. Diseases Characterized by Genital, Anal, or Perianal Ulcers*. Atlanta, Georgia: Centers for Disease Control. Available at: http://www.cdc.gov/std/treatment/2010/genital-ulcers.htm#hsv.

46. Farley TA, Cohen DA, Elkins W. Asymptomatic sexually transmitted diseases: The case for screening. *Preventive Medicine* 2003; 36(4): 502-9.

47. Bernstein DI, Bellamy AR, Hook EW 3rd, et al. Epidemiology, clinical presentation, and antibody response to primary infection with herpes simplex virus type 1 and type 2 in young women. *Clinical Infectious Diseases* 2013; 56(3): 344-51.

48. Nilsen A, Myrmel H. Changing trends in genital herpes simplex virus infection in Bergen, Norway. *Acta Obstetrica et Gynecologica Scandinavia* 2000; 79(8): 693-6.